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TWO SIMILAR CLASSROOMS WERE SET UP IN THE LENNOX LIVING LABORATORY, DES MOINES, IOWA, ONE FOR EXPERIMENTAL GROUPS AND ONE FOR CONTROL GROUPS. TEMPERATURE, AIR CIRCULATION AND HUMIDITY CAN BE CONTROLLED AND MEASURED IN BOTH ROOMS. THE ROOMS ARE OF SIMILAR SIZE, LAYOUT AND CONSTRUCTION, THE THERMAL ENVIRONMENT BEING THE ONLY VARIABLE. THE FOLLOWING QUESTIONS WERE STUDIED IN THE EXPERIMENTAL SCHOOLHOUSE--(1) IS THERE A DIFFERENCE BETWEEN BOYS' AND GIRLS' REPORTED COMFORT. (2) IS THERE A DIFFERENCE BETWEEN BOYS' AND GIRLS' REPORTED FEELINGS OF COMFORT IN THE SAME ENVIRONMENT. (3) WHAT IS THE EFFECT OF TEMPERATURE AND HUMIDITY ON REPORTED STUDENT COMFORT. (4) WHAT IS THE ACTUAL OPERATING TIME OF THE HEATING, COOLING, AND VENTILATING EQUIPMENT WHEN MAINTAINING THE IDEAL THERMAL ENVIRONMENT. RESULTS ARE GIVEN TO THESE FOUR QUESTIONS. (RH)

ED020644

Education, Children and Comfort

The University of Iowa

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
OFFICE OF EDUCATION

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Interim Report on the Effects of Thermal Environment on Learning by:

The Educational Psychology and Educational Administration Departments, University of Iowa; the Iowa Center for Research in School Administration; the Saydel, Iowa, School District and Lennox Industries Incorporated. December 1965.

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FORWARD

The material contained in this brief research report is a portion of the research done by Robert McCardle on the relationship of Thermal Environment to Learning. This material relates to some of the aspects of McCardle's research which was not directly related to learning. The report on learning and thermal environment will be produced in the spring of 1966.

We thought that our readers would be interested in these findings. The Iowa Center for Research in School Administration has a third study underway, which will be available in the summer of 1966. This study is focused on temperature and learning.

Burdette Hansen is conducting a third study on learning and temperature which will be available in the spring of 1966. We are also indebted to him for the statistical analysis in this report.

Once again, we want to thank Lennox Industries, and the superintendent and staff of the Saydel School system for their cooperation and help. This demonstrates that it takes a partnership of a State University, Industry, and a public school system to get at many aspects of the educational endeavor.

Sincerely yours,

Willard R. Lane

Director, Iowa Center for Research in School Administration, University of Iowa, Iowa City, 1965

The Lennox Living Laboratory was built in 1956 by Lennox Industries for educational research. It has two identical classrooms, one for experiment and one for control. Humidity, air circulation and temperature can be controlled in the building. Size, construction and layout of the two classrooms are identical, making the thermal environment the only variable. Standard school construction and materials were used in the building.

Background

Working as a team, members of the University of Iowa, Iowa Center for Research in School Administration, the Saydel School District and Lennox Industries have completed two studies of classroom comfort.

Conducted by Dr. Charles Peccolo, the first study investigated effects of thermal environment on learning.

Dr. Peccolo's study used 44 matched pairs of fourth grade students. Data was collected from March 19 to May 1, 1962, with each group participating three weeks. A repeated series of ten paper and pencil tests served as the learning task.

Results indicated:[1]

a. Achievement in all reasoning and some clerical tasks is significantly higher in an ideal thermal environment, than in the typical thermal environment.
b. Learning new concepts improves in the ideal thermal environment, but not enough for significance at the .05 confidence level.
c. The ideal thermal environment is the best learning environment for all tasks measured, but the effect varies.

The second study, under Robert McCardle's supervision, followed the Peccolo study. McCardle's study used 40 matched pairs of sixth-grade students for eight weeks, October 15 to December 14, 1962. Measuring tasks were:

1. performance of routine arithmetic
2. memorizing French words and their meanings
3. use of programmed learning materials in science

4. time placement effect on achievement

This report is being written now.

During Dr. Peccolo's study, several questions arose. These questions were:

a. Is there a relationship between intelligence and reported comfort?

b. Is there a difference between boys' and girls' reported feelings of comfort in the same environment?

c. What is the effect of temperature and humidity on reported student comfort?

d. What is the actual operating time of the heating, cooling and ventilating equipment when maintaining the ideal thermal environment?

Extra research was carried out during McCardle's experiment in an attempt to answer these questions. This report covers these findings;

McCardle's main study will be available soon.

Procedure

Two classrooms were set up in the Lennox Living Laboratory, Des Moines, Iowa. Lennox Industries built the school in 1956 for research and development of better classroom comfort. The building has two similar classrooms, one for experiment groups and one for control. Temperature, air circulation and humidity can be controlled and measured in both rooms. The rooms are of similar size, layout and construction. This makes the thermal environment the only variable.

Building materials used are identical with those found in most conventional school buildings.
Both rooms used 12 point Type 153 Electronik Recorders for a continuous printed record of temperature and humidity. Brown Instruments Thermo-Humidigraphs recorded continuous temperature and humidity at the students' original schools.

The recorders' accuracy was checked twice daily with a Taylor mercury thermometer.

To record individual student comfort, each student periodically filled out a form. On this form the student circled the time and room number, wrote down his name and the date, and checked whether he felt too warm, too cold or just right. 25 spaces allowed the student to indicate to what degree he felt warm or cool.

One room maintained an "ideal" thermal environment, the other a typical classroom environment.

In the ideal thermal environment, the temperature normally stayed between 70 and 74 degrees, averaging 72. Relative humidity usually measured between 35 and 61 percent, air movement ranged between 20 and 45 feet per minute.

For the typical classroom, actual conditions were recorded in classrooms at Canary Lake School and Saylor Center School. These conditions were then reproduced in the typical classrooms, with an average temperature of 77 degrees. The range was greater, usually varying between 71 and 81 degrees. Humidity was normally between 26 and 48 percent, air movement between 15 and 25 feet per minute when heating was required.

Results

Many of the students in the ideal thermal environment reportedly felt cool. An interesting aspect is that they generally reported feeling cool in the morning but said they felt comfortable in the afternoon. The thermal environment was constant.

Results also show that girls' thermal needs may differ from boys'. Generally, the girls reported feeling cooler than the boys. In the ideal classroom, girls reported feeling cool 63.6 percent of the time; the boys indicated feeling cool only 22.2 percent of the time. This is significant at the .05 confidence level. In the typical classroom there was no difference at the .05 confidence level between the boys' and girls' indications.

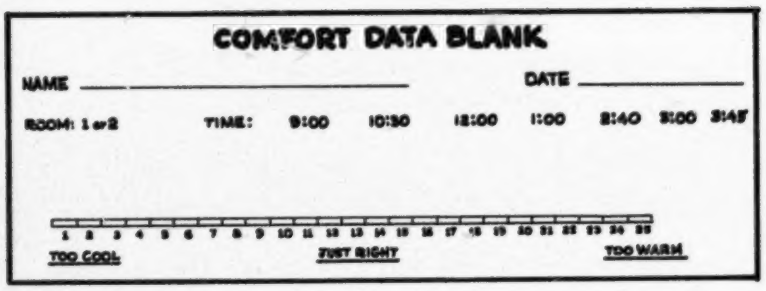
During the study, the air conditioning equipment was used over twice as much as the heating equipment. The experiment took place in October, November and December, a chilly time of year in Iowa. While a surprise to some of the researchers, Lennox technicians explained this was due to normal internal heat gains. Most schools have teachers, many children and lights contained in a relatively small space. The heat they generate, plus heat from the sun, actually creates a need for cooling or ventilating, even when outside temperatures are near freezing. Equipment operational time showed the school needed cooling much more than heating. This study did not find a statistically significant relationship at the .05 confidence level between the students comfort reports and I.Q. scores. In the ideal environment, no significant difference in achievement was noted between the students reporting feeling comfortable and those reporting feeling slightly warm or cool.

As expected, the students in the ideal environment reported being comfortable more often. 65.7 percent of the responses from the ideal environment and 34.2 percent of the responses in the typical environment indicated comfort.

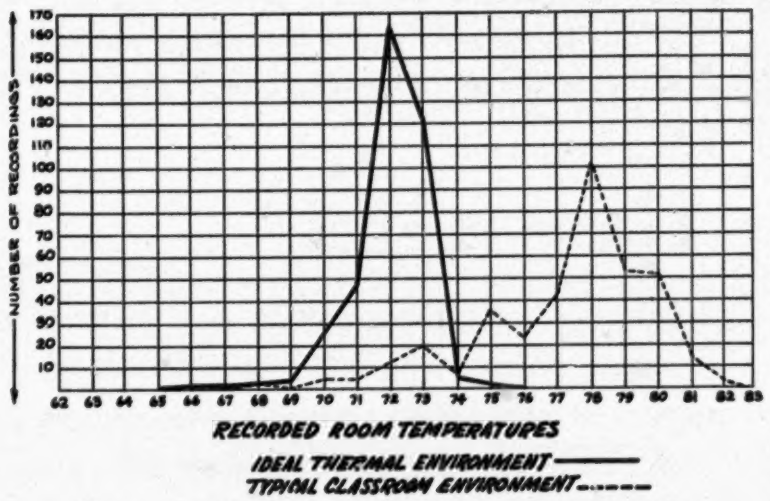
In the ideal environment, the students seemed to feel cooler in the morning than in the afternoon, despite a constant environment. The girls generally seemed to feel cooler than the boys in the ideal environment. The students in the ideal classroom reported feeling comfortable more than the students in the typical classroom.

[1]A digest of Charles Peccolo's Ph. D. Dissertation, The Effects of Thermal Environment on Learning, Iowa Center for Research in School Administration, Iowa City, 1962.

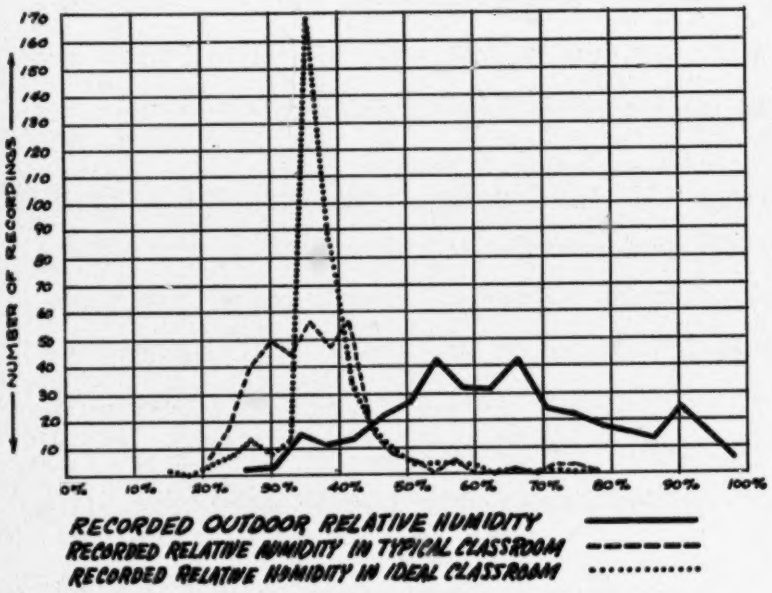
Illustrated Results



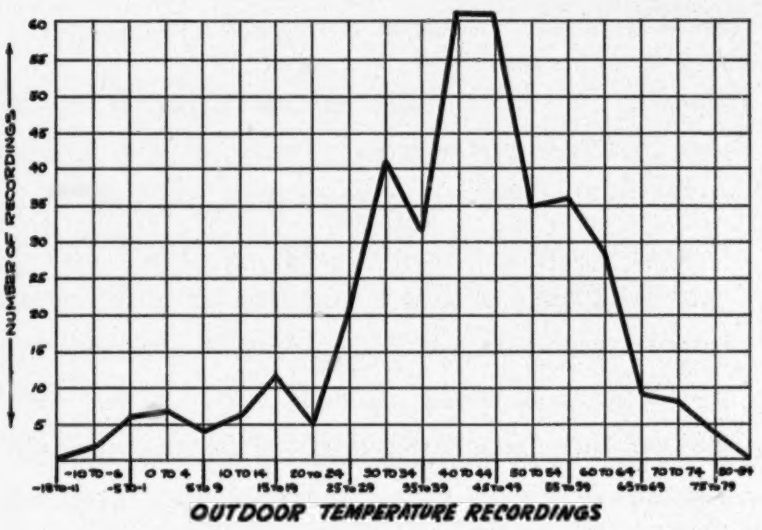
25 spaces on the comfort data blanks let the students indicate how cool or how warm they felt. Then they wrote in their name and date, and circled the time and room number. In all, 7026 of these blanks were filled out and turned in to the researchers.



Average temperature in the ideal classroom was 72 degrees, and normally stayed close to 72. The typical classroom, with an environment duplicating temperatures found in actual sample classrooms, had higher temperatures. Average temperature in the typical classroom was 77 degrees and varied more than the temperatures in the ideal environment.

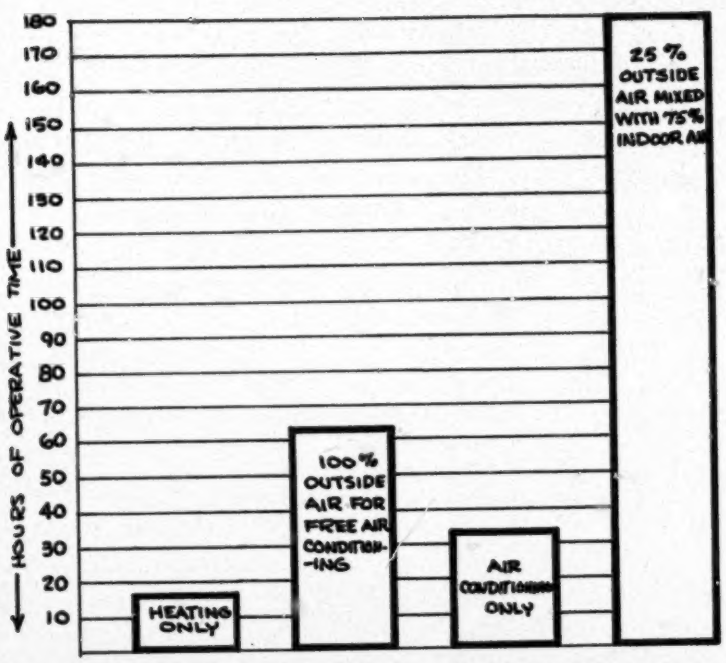

NUMBER OF RECORDINGS
RECORDED OUTDOOR RELATIVE HUMIDITY
RECORDED RELATIVE HUMIDITY IN TYPICAL CLASSROOM
RECORDED RELATIVE HUMIDITY IN IDEAL CLASSROOM

Relative humidity averaged 37.9 percent in the ideal environment and 36.3 percent in the typical classroom. Outdoor humidity ranged between 100 and 25 percent during the test, averaging 64.2 percent.



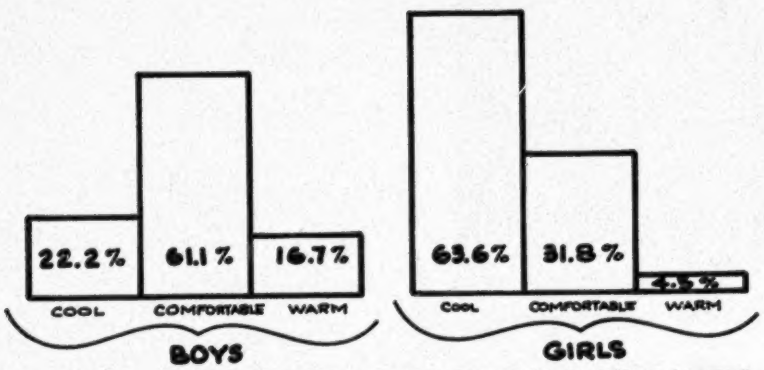
During the experiment, outdoor temperatures ranged from 76 degrees above zero to 10 below, averaging 42.2 degrees. Despite these cool outdoor temperatures, the building used cooling more than twice as much as it used the heating equipment. This is due to normal internal heat gains caused by sunlight, lights and body heat.

Illustrated Results



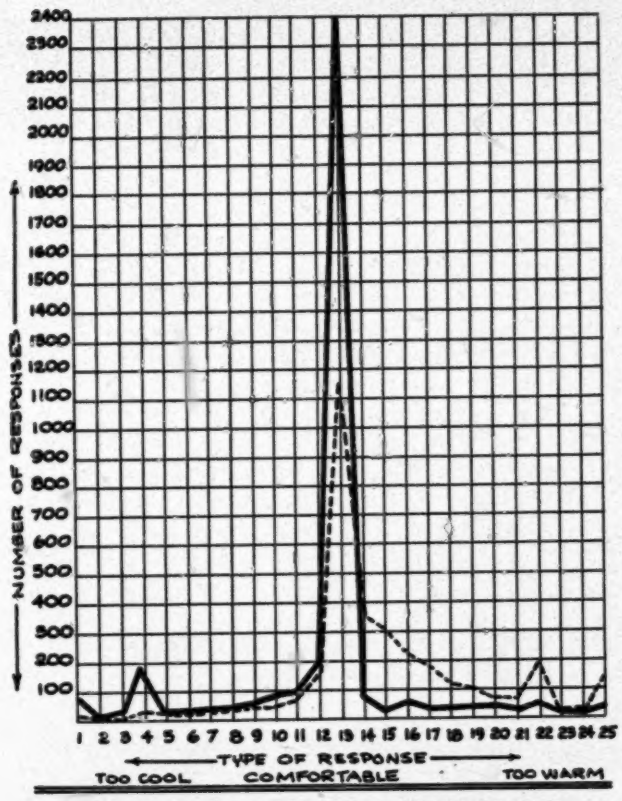
EQUIPMENT OPERATION DURING OCCUPIED HOURS OCT. 15 TO DEC. 14, 8:45 A.M. TO 3:45 P.M.

During the occupancy, the heating equipment operated 5.2 percent of the time, the mechanical cooling equipment operated 33 percent of the time. 61.8 percent of the time neither the heating or cooling equipment operated. During the 33 percent cooling time, mechanical cooling accounted for only 11.3 percent of the cooling time. In the remaining time, 21.7 percent, outside air was used to fill the cooling needs. At least 25 percent outside air was always used to keep the air fresh.



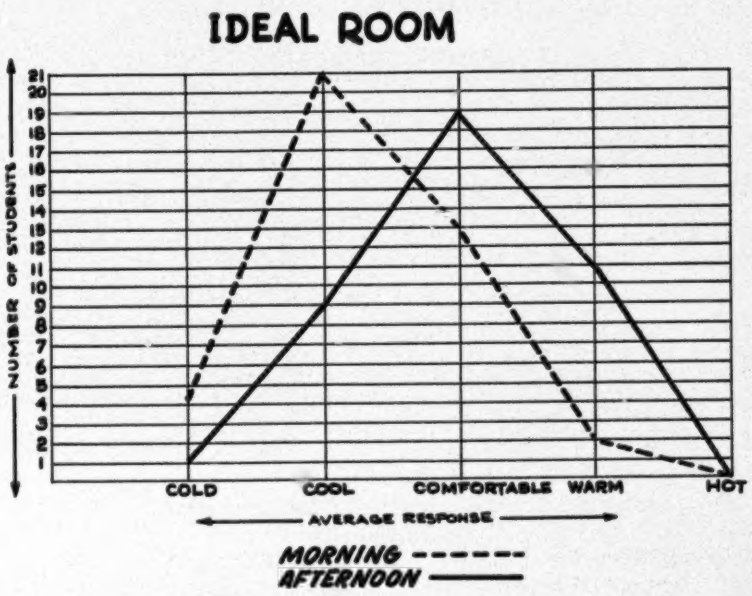
AVERAGE RESPONSE OF BOYS COMPARED WITH GIRLS IN THE IDEAL CLASSROOM ENVIRONMENT

The girls reported feeling cooler than the boys in the ideal classroom. 63.6 percent of the girls usually indicated feeling cool, while only 22.2 percent of the boys in the same room usually reported feeling cool. These results are statistically significant at the .05 confidence level. There was no statistically significant difference at the .05 level between boys and girls in the other classroom.

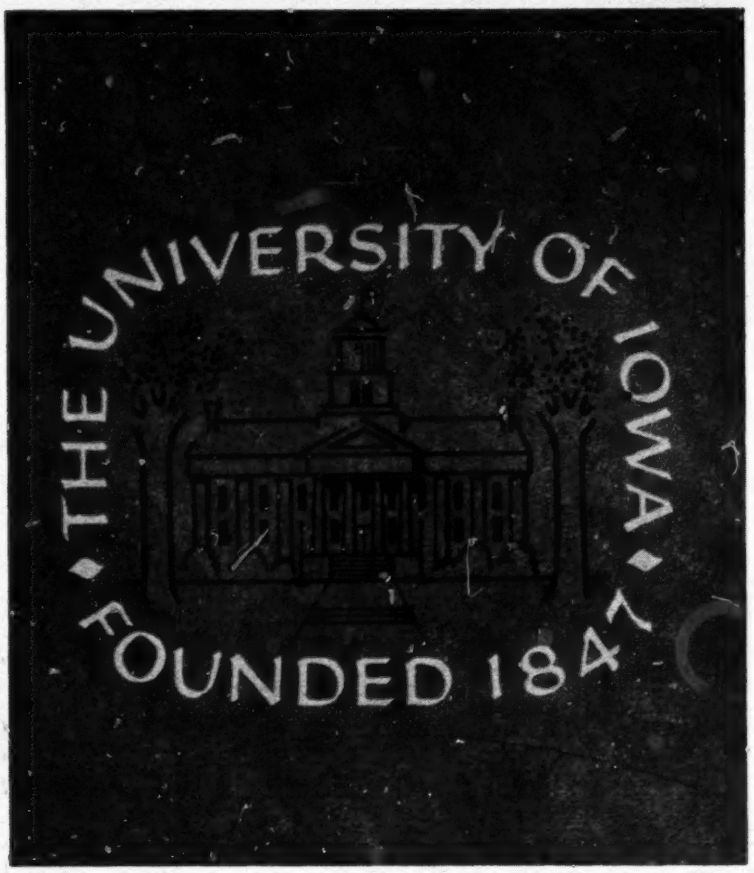


RESPONSES FROM IDEAL ENVIRONMENT ——
RESPONSES FROM TYPICAL ENVIRONMENT ----

There were 3651 responses from the ideal room and 3365 from the typical room. 34.2 percent of the responses from the typical classroom indicated comfort, 65.7 percent reported comfort in the ideal classroom.



In the ideal thermal environment, the students indicated feeling cool or cold more frequently in the morning. Despite a constant thermal environment, the students generally reported feeling cool in the morning and comfortable in the afternoon.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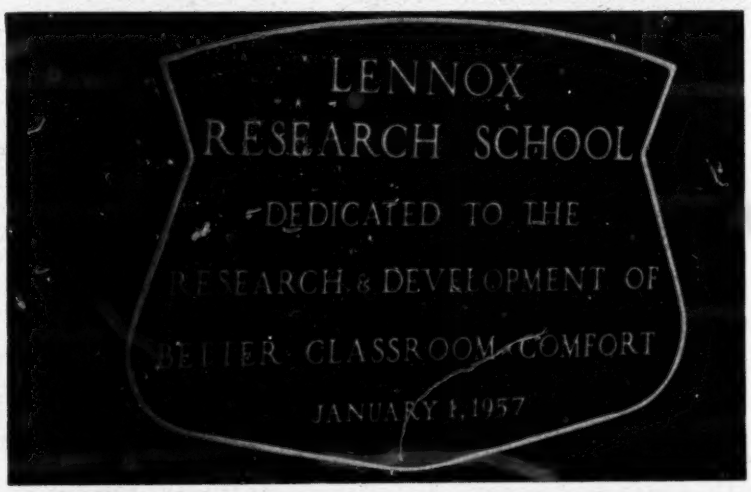
LENNOX
RESEARCH SCHOOL
DEDICATED TO THE
RESEARCH & DEVELOPMENT OF
BETTER CLASSROOM COMFORT
JANUARY 1, 1957